Management information: Gymnodinium catenatum

Preventative measures:

To prevent the spread of cells or cysts, movement of water, shellfish spat, or potentially contaminated materials, such as mussel ropes, should be restricted. Fishermen and boat-owners should remove water from the sumps of boats and wash any equipment such as scuba gear that has been used in the water. Vehicles that have been used on toxin-affected beaches should be washed thoroughly with fresh water, especially the undercarriage (NZFSA, 2004).

A technique for easily detecting the presence of G. catenatum in ballast water has been developed in Australia. It involves seawater sample extraction of DNA, and the amplification of a target-specific "DNA signature" to identify the presence of G. catenatum. This allows ballast water to be tested more accurately and cheaply than the costly screening processes used previously (CSIRO, 2004).

Physical:

Electrical shock has had limited success. Cyst viability in laboratory cultures was reduced to 60% by application of voltages of 5 volts/cm², 10% at 6.25 and 7% at 7.5 volts/cm². Killed cysts exhibited a bleached appearance indicative of chemical action and tests for chlorine indicate that death was not caused by electric shock but the consequent generation of free chlorine and potentially localised temperature increases. For example, voltages up to 30 volts increased temperatures up to 25°C from 17°C. Heat treatment experiments using G. catenatum (30-90 seconds at 40-45°C) were effective in killing cysts and motile cells. Germination of cysts was unaffected by temperatures up to 35°C, but no germination occurred after heating to 45°C or higher. Exposure to cysts for 150 seconds to temperatures 36-38°C reduced germination by 65 - 75% and inactivation of cysts occurred
by exposures ranging from 120 seconds at 38-40°C to 30 seconds at
temperatures of 44.5-46.3°C. Ultra-violet radiation has been successfully trialed as a treatment option for ballast water to disable toxic algal cysts and vegetative cells. However, it is difficult to implement (McEnnulty et al., 2001).

The use of basic oxygen furnace (BOF) slag on the sediments seed bank of *G. catenatum* has the potential to inhibit the germination of resting cysts, by reducing the concentration of inorganic salts and H2S in seawater and sediments (Yoo and Shin, 2004).

**Chemical:**

Cysts exposed for 24 hours to freshwater showed some disruption to their cell contents, but surprisingly their viability was unaffected. Similarly exposures to salinities in the range 15 - 50ppt and only treatment with extreme salinities as high as 100% prevented their successful germination. Copper sulphate has been trialed as a control for species in ballast water. Motile dinoflagellate cells are readily killed at concentrations of 1mg/l but has only minor effects on dinoflagellate cysts (68% germination at concentrations as high as 200 mg/l). However it is too costly to be deployed on a large scale. The use of hydrogen peroxide is highly successful. Effective treatment to prevent germination of dinoflagellate cysts in seawater samples could be achieved with high concentrations of hydrogen peroxide (at 5000 ppm there was 2% germination; at 10,000 ppm there was no germination in a 24 hour period).

Chlorine (sodium hypochlorite, sodium azide) and electrolysis of seawater to produce chlorine (NaOCl) has been used on ballast water to disable toxic algal cysts and vegetative cells including *G. catenatum*. This technique has met with limited success. (McEnnulty et al. 2001).